

**GENERAL DEFINITION OF THE REST ENERGY:
EVIDENCE FROM THE PRIMORDIAL UNIVERSE
A NEW THEORY**

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Abstract

The goal is to search for the conditions required for a compact closed sphere filled with baryonic particles in a bound state to have rest energy simulating to that of an isolated, free single particle: zero-internal electric and quantum energies. When we begin and return all the relativistic relations to the original relativistic rule: speed of light is constant regardless the motion of the source or the observer, we will discover a general new definition of the rest energy. This proposed rest energy of the entire sphere gives (and is realized by) a physical meaning for the imaginary relativistic solution: $m^2 = -m_0^2$

Keywords: Quantum degeneracy pressure, Electric field, Gravitational potential, Rest energy, Negative mass.

Introduction

Let us begin from the fact that the speed of object never exceed speed of light [1], and from the common definition of the inertial rest state: m_o , r_o and E_o of an isolated baryonic particle which is stated by the Einstein's famous equation:

$$k \frac{e^2}{r_o} = E_o = m_o c^2 [2]$$

This paper searches in the conditions required for new general definition of the above equation to include a closed compact non-conducting sphere S, formed of sub-atomic particles, and taking the form

$$(E_o)_s = E_o n = n m_o c^2 = M_o c^2$$

This system (which has a defined density, and defined physical properties) has net kinetic energy equals zero: electric E_e , magnetic E_m , quantum E_q , and the small gravitational E_g

$$E_e + E_m + E_q + E_g = 0$$

The synonym meaning of the above form is to say that; the kinetic energy of the electromagnetic field E_e inside our sphere is zero, if and only if we succeeded to put the whole sphere on the form of Einstein's equation. To do that, we have to begin from looking for a formula to fix the Coulomb equation on the form of Einstein's equation. So, let us put the kinetic energy of the electric field inside our sphere (which is the half of the electromagnetic field in our case) in the form of: $\frac{1}{2} k \frac{e^2}{r_o} = \frac{1}{2} m_o c^2$

Now, subtracting the small term E_g gives the relativistic relation:

$$E_e + E_m + E_q \approx \text{nonzero positive quantity}$$

The above sign ($\approx$) guarantees that we deal with real subatomic particles whose speed never equal that of light ($v \approx c$). To keep the above two equations alive we have to impose alternate relativistic relations. We may notice that the small term E_g has a radical role (although it has comparatively very small quantity) because its presence in the equation realizes the case of $v^2 = c^2$ as additional intrinsic property of the particles inside the sphere as expression of new additional definition of the rest energy of the whole sphere, while eliminating

the equation from this term realizes the state $v^2 \approx c^2$ which represents a dramatic deviation from the first case and needs alternative relativistic solution.

In the first section we will discuss the required conditions which include the density and the physical properties of this proposed sphere. In the second section we will see that this physics succeeds to construct a system. The surprise was that this system has physical properties matching that of our solar system.

The core idea of the paper is built on equating the kinetic energy of each of the above three terms of the above equation with that of Einstein equation like that: $k \frac{e^2}{r_o} \left(\frac{r_o p}{r_c n^{\frac{1}{3}}} \right) = k \frac{e^2}{r_o} \times 1 \equiv m_o c^2$ if, and only if the in-between brackets equal one.

Yes, this proposed sphere runs against the current physics because, according to Fermi-Dirac statistics, the particles with energies greater than Fermi energy have zero probability to exist, and also according to special relativity $v = c$ is forbidden, therefor our strategy will be discussion the physics of the sphere regardless these contradictions in the first section of the paper, and then in the section of thermodynamics we will see the probability of finding of this sphere in the primordial universe taking in consideration the above objections.

Discussion

I- If we defined a closed non-conducting sphere S , formed of number of protons p , distributed homogeneously in much more number of neutrons n , and if we equated the quantity $\frac{r_o p}{r_c n^{\frac{1}{3}}}$ with the number one we can get

$$k \frac{e^2}{r_o} \left(\frac{r_o p}{r_c n^{\frac{1}{3}}} \right) \equiv k \frac{e^2}{r_o} \times 1 = E \equiv E_o \equiv m_o c^2 \quad (1)$$

This is a nontrivial solution defines the initial conditions ($m = m_o$ and r_o is the old classic rest radius of the particle while, $r_c n^{\frac{1}{3}}$ is the radius of the system in this bound state.

$$\text{And, } r_c = r + \Delta r \approx \frac{\hbar}{mc} \approx \text{Compton length} \quad (2)$$

We can consider r_c unknown that we have to estimate its accurate value in the bound state.

From the above we can do the next intuitive mathematic operation

$$\frac{1}{2} m_o c^2 \equiv k \frac{e^2}{r_o} \left(\frac{1}{2} \frac{r_o p}{r_c n^{\frac{1}{3}}} \right)$$

That is if (and only if) the in-between brackets equal half.

And then we choose a very small cut of energy ΔE equivalent to the extra Δr of equation 2

$$\Delta E = k \frac{e^2}{r_o} \frac{n}{p \mu} \quad (3)$$

where μ is a new unknown we have to find its value, and

$$\frac{n}{p \mu} \ll 1$$

$$\therefore E_o \approx \frac{1}{2} m_o c^2 \approx \frac{1}{2} k \frac{e^2}{r_o} \left(\frac{r_o p}{r_c n^{\frac{1}{3}}} - \frac{n}{p \mu} \right) \quad (4)$$

Or, we can write it in the form

$$\frac{k e^2}{r_o} \left(\frac{1}{2} \frac{r_o p}{r_c n^{\frac{1}{3}}} - \frac{1}{2} \frac{n}{p \mu} \right) = \frac{1}{2} m_o v^2 \sim \frac{1}{2} m_o c^2 \quad (5)$$

It looks like Coulomb's form of a particle with non-transitional motion: its right side represents the kinetic energy as defined by the forthcoming equation 12, while its left side represents half the electromagnetic energy of each charged particle of the sphere. The particles inside the sphere S possesses motional property ($v \sim c$) representing the microstates inside the sphere. The above is the first face of the coin, while its second face appears when we insert the approximate relation of equation 5 into the Einstein's equation by adding the positive term (which is equation 3) to appear as the next strict equality

$$\frac{1}{2} k \frac{e^2}{r_o} \left(\frac{r_o p}{r_c n^{\frac{1}{3}}} - \frac{n}{p \mu} \right) + \frac{1}{2} k \frac{e^2}{r_o} \frac{n}{p \mu} \equiv \frac{1}{2} m_o c^2 \quad (6)$$

The speed v in equation 5, appears in the above macro state as intrinsic physical property or (silent) speed; $v = c$

If the free isolated particle was defined by

$$r_o = k \frac{e^2}{m_o c^2}$$

Then the bound one inside the big sphere gets new additional definition $r_c \approx \frac{\hbar}{mc}$

(7)

This gives intrinsic property for the particles:

$$v^2 \approx c^2 \quad (8)$$

If equation 3 equals the gravitational potential

$$u_g = \Delta E = \frac{1}{2} m_o u^2 \text{ where } u \ll c \quad (9)$$

Then, we can rewrite equation (1) as follows

$$\frac{1}{2} m_o c^2 \equiv \left(\frac{1}{2} k \frac{e^2}{r_o} \frac{r_o p}{r_c n^{\frac{1}{3}}} - u_g \right) + u_g \equiv \frac{1}{2} m_o v^2 + \frac{1}{2} m_o u^2 \quad (10)$$

The quantity between the brackets arises only from the spaces between the particles as defined by equations 3, 7 and 8, but when we add the gravitational energy (later on, in equation 21 we will see that this added energy is a positive quantity) we get the whole equation (the macrostate). The quantity u_g inside the brackets is the cut energy mentioned in equations 3, 4 and 5 due to the extra size Δr mentioned in equations 2

All the microstates inside the sphere should be defined finally by the initial conditions of equation 1.

$$m = m_o \quad \& \quad r = r_o \quad \& \quad E = E_o \quad (11)$$

The kinetic energy in our alternative relativistic solution is defined by the initial condition (look at equation 1):

$$\therefore m = m_o$$

Therefore this enables us to put the mass outside the next integral

$$E_k = \int F \cdot dr = \int m_o \frac{dv}{dt} v dt = m_o \int \frac{dv}{dt} v dt = \frac{1}{2} m_o v^2$$

And from equation 10

$$\frac{1}{2} (m_o v^2 + m_o u^2) = \frac{1}{2} m_o c^2$$

$$v^2 + u^2 = c^2 \quad (12)$$

The free particle loses a bit of its mass to reside in a bound state. Here in our sphere, the particle- like rest energy loses a bit of energy $\Delta E \equiv u_g$. After adding the gravitational kinetic energy $\Delta E = u_g$ we get the general form of equation 1, 10 and 12 (rest energy).

Now, the goal is to realize all the above abstract mathematic equations inside the sphere. That is to prove physically that all the energies: the electric u_e , the 'quantum exclusive' u_c and the gravitational u_g in addition to the energy of the magnetic moment u_s are added as: $(u_e + u_s) + u_g \equiv m_o c^2$.

$$u_c + u_g \equiv m_o c^2$$

If we succeeded to do that then we can say that we realized equation 1, hence we can deal the entire energy of the big sphere as rest energy. So, we can deal the total kinetic energy as summation of zeros (rest energy of the entire sphere). Let us go step by step:

1- The electric field inside the sphere

Let us define

$$\gamma^2 = \frac{1}{1-\beta^2} \equiv c_o \quad (13)$$

where $\beta^2 = \frac{v^2}{c^2}$ and c_o is a new symbol.

$u_e \gg u_g$ while the relativistic electric energy $u_e(v)$ is affected by one γ , while the gravitational $u_g(v)$ is affected by γ^3

$$u_e(v) = k e^2 p \frac{\gamma}{r_s} = m_o c^2 \quad (14)$$

Such that $r_s = r_c n^{\frac{1}{3}}$

$$u_g(v) = -G(m_p n m_n \gamma^2) \frac{\gamma}{r_s} = \frac{1}{2} m_o c^2 \quad (15)$$

So, when $v \approx c$ as in equations 2, 4 and 8, and from equations 14 and 15 we can define $\frac{n}{p}$ to reach the equality

$$u_g(v) = u_e(v) \quad (16)$$

Inside a closed sphere, the Gaussian surface could be applied to the gravitation and electric field, so at any point we have the same equality. If $m_p \approx m_n$ then from equation 13 we can realize the existence of the sphere by equating the electric energy per proton to the gravitational energy per the same proton. We can use the new symbol, of equation 13, in the equality

$$u_e(v) = k e^2 p \frac{c_o^{\frac{1}{2}}}{r_s} = u_g(v) = -G n m_o^2 c_o \frac{c_o^{\frac{1}{2}}}{r_s} \quad (17)$$

This equation represents the microstate inside the sphere and should be bounded by the initial conditions of equations 1 and 11: $r = r_o$ and, $m = m_o$

So, we have to do cancelling for the factor c_o between both sides (and between the numerator and denominator if needed). After cancelling, we can get

$$\frac{1}{2} k \frac{e^2}{r_o} = \frac{1}{2} k e^2 \frac{p}{r_s} = -G(n c_o) \frac{m_o^2}{r_s} = \frac{1}{2} m_o c^2 = u_g(v) \neq u_e(v) \quad (18)$$

(where r_o and r_s are defined in equation 14). You notice the factor $n c_o \equiv n \gamma^2 = N$ appears as alternate relativistic solution and $u_g(v)$ is atypical potential (doesn't take the form $u_g(v)$)

2- The quantum state inside the sphere

On the same way of Fermi sphere we can understand the Compton sphere defined by equations 2 and 7

The particles density is the inverse of infinitesimal volume

$\frac{n}{V}$. The quantum energy density inside the neutron well

$$u_c = \frac{\hbar^2}{2m} \left(\frac{3\pi^2}{V} n \right)^{\frac{2}{3}} = \frac{A}{r_c^2 m_o} \quad [3]$$

where A is a non-arbitrary constant. As we did in equation 17, and respecting the initial conditions we can process the cancelling to the relativistic equation to get

$$u_c(v) = \frac{A c_o^{\frac{1}{2}}}{r_c^2 m_o}$$

Again, as we did in equation 16 and 17, we expect the equality

$$\frac{A}{r_c^2 m_o} = u_c = - \frac{G m_o^2 (n \cdot c_o)}{r_s} = u_G(v) \neq u_g(v)$$

Again the factor $nc_o = \gamma^2 n$ appears as alternate relativistic solution which we will discuss later on.

3- The imaginary and the alternate relativistic solution

You can notice equations 18 and 19 speak about the quantity $\approx \frac{1}{2} m_o c^2$ and not the quantity $= \frac{1}{2} m_o c^2$.

So, we search for a solution realizes a complete (not approximate) equality like:

$$\frac{1}{2} u_e(v) + u_g = \frac{1}{2} m_o c^2$$

$$u_c(v) + u_g = m_o c^2$$

where u_g is the non-relativistic gravitational energy.

Let us apply the imaginary solution

$$\text{At } v^2 = 2c^2 \quad (19)$$

$$\therefore m^2 = \frac{m_o^2}{1 - \frac{v^2}{c^2}}$$

$$m^2 = -m_o^2 \quad (20) \therefore$$

And then insert it in equation 17

$$-Gn \frac{-m_o^2}{r_s} = Gn \frac{m_o^2}{r_s} = \text{positive non-relativistic } u_g \quad (21)$$

You can notice that the negative relativistic quantity $u_G(v)$ of equation 18 (It is not the proper gravitational potential) which carries the alternate relativistic solution is transformed inside equation 21 into positive non relativistic quantity.

This positive energy could be added to u_c and u_e

$$u_c + u_g = 2u_e + u_g = m_o c^2. \quad (22)$$

But, **how is equation 19 realized?**

Each particle inside the sphere has its own rest intrinsic energy $= m_o c^2$ which expresses its own rest radius $r_o = k \frac{e^2}{m_o c^2}$

And here, we add from equation 19 another half

$$(\frac{1}{2} m_o c^2).$$

This additional half expresses the additional space length of equation 2 which is $r_c \approx \frac{\hbar}{mc}$. This new state, as we will show, adds for the charged particle a second half coming from its own magnetic moment (as we will see). So, as a net result, the charged particle obeys

$$m_o c^2 + (\frac{1}{2} m_o c^2 + \frac{1}{2} m_o c^2) = 2m_o c^2 = m_o (2c^2) \quad (23)$$

And the neutron particle obey

$$m_o c^2 + (m_o c^2) = 2m_o c^2 = m_o (2c^2)$$

You notice that the particle does not duplicate its mass, such that the equation realizes equation 19. Equation 22 shows the deep meaning of the alternate relativistic solution of equations 18 and 19 as multiplication of the particles by the factor c_o

It is replication of the rest energies which defined by $r_o = k \frac{e^2}{m_o c^2}$ and $r_c = \frac{\hbar}{mc}$

The operation $nc_o = N$ means replication of the null sets or zeros of energy. The point which we have to stress on well is that the process of multiplication (replication) does not mean true creation of new particles but it means only conquering and grab of the surrounding particles existing outside the sphere into the inside of the sphere (which is coincident with the atypical potential appearing in equation 18). That is to say; it is replication of the rest state ($v^2 = c^2$) of the particles of the sphere while the entire number of the particles of the universe is constant [4]. Equation 23 means addition of rest energies not frank addition of speeds. It gives only the physical description of the negative mass.

The final form is $c_o n = N$ or:

$$\sum_n^N E_o = \sum_n^N m_o c^2 = \sum_n^N \text{zeros} = \frac{N}{n} m_o c^2$$

$E_o = m_o c^2 = f(r_c) = f\left(\frac{\hbar}{m_o c}\right)$. This is equivalent to

$$E_o = f(r_o) = f\left(\frac{ke^2}{m_o c^2}\right) \rightarrow \sum_n^N E_o = \frac{N}{n} m_o c^2$$

The net result is multiplication (replication) of the sphere by the same factor. The above addition occurs only if, and only if, the density is still obeying equations 2 and 7.

Up till now, each proton inside the sphere has

$$\frac{1}{2} u_e(v) + u_g = \frac{1}{2} m_o c^2$$

The Fermi (Compton) energy of the proton is neglected because it only applies for fermions of the same type: that is to say the distance between each two neighbor protons is so long ($p \ll n$) comparative to that of neutrons.

Now we will search for the remainder half. Let us at first study the free particle as defined by $r_o = k \frac{e^2}{m_o c^2} \rightarrow E_o = m_o c^2$

This could be seen as formed of two halves ($2 \frac{1}{2} m_o c^2$)

The electric energy density $u = \frac{1}{2} E^2 \epsilon_o$

$$u_x + u_y + u_z = u = 3 \frac{e^2}{32 \pi^2 a^4 \epsilon_o} \int_0^{2\pi} \int_0^\pi \int_0^r r^2 \sin\theta \, dr \, d\theta \, d\varphi$$

$$= \frac{e^2}{8\pi\epsilon_o} = \frac{1}{2} m_o c^2$$

The spin of the particle adds the second half as follows

$$u_s = m \cdot B = (i\pi a^2) \cdot B$$

$$B = \frac{\mu}{4\pi a^2} i \int dl = \frac{\mu i}{2r}$$

$$i = \frac{e}{T} = \frac{ev}{2\pi r} \rightarrow B = \frac{\mu ev}{4\pi a^2}$$

from all above

$$u_s = \frac{e^2}{8\pi\epsilon_o} = \frac{1}{2} m_o c^2 \quad (24)$$

4- The average energy density in our sphere

$$\frac{1}{2} k \frac{e^2}{r_o} \approx \frac{1}{2} k e^2 \frac{p}{r_s} \approx \frac{1}{2} m_o c^2$$

$$u_c = \frac{\hbar^2}{2m} \left(\frac{3\pi^2}{V} n \right)^{\frac{2}{3}} \approx m_o c^2$$

And, from equation 18 we have

$$- \frac{G m_o^2 (n \cdot c_o)}{r_s} = u_G(v) = \frac{1}{2} m_o v^2 \approx \frac{1}{2} m_o c^2$$

Which appears in the imaginary solution as positive u_g could be added to u_c and u_e (equation 22).

$$\int_0^n u_c dn = \frac{\hbar^2}{2m} \left(\frac{3\pi^2}{v}\right)^{\frac{2}{3}} n^{\frac{2}{3}} dn = \frac{3}{5} u_c n$$

$$u_a = \frac{3}{5} u_c = \frac{3}{5} \frac{\hbar^2}{2m} \left(\frac{3\pi^2}{v}\right)^{\frac{2}{3}} n^{\frac{2}{3}} = m_o c^2 \quad (25)$$

And the average electric energy becomes

$$\frac{3}{5} k \frac{e^2}{r_o} \left(\frac{r_o p}{r_c n^{\frac{1}{3}}}\right) \equiv \frac{3}{5} k \frac{e^2}{r_o} \times 1 = E \equiv E_o \equiv m_o c^2 \quad (26)$$

And the negative quantity (not properly gravitational binding energy) takes the form

$$-\frac{3}{5} \frac{G m_o^2 (n.c_o)}{r_c n^{\frac{1}{3}}} = -\frac{3}{5} \frac{G m_o^2 (N)}{r_c n^{\frac{1}{3}}} = u_G(v) \approx \frac{1}{2} m_o c^2 \neq u_g(v) \quad (27)$$

5- Definition of the giant proton:

$$\therefore u_c = \frac{3}{5} \frac{\hbar^2}{2m} \left(\frac{3\pi^2}{V}\right)^{\frac{2}{3}} n^{\frac{2}{3}} = m c^2$$

$$\therefore r_c = 2.2 \times 10^{-16} m \quad (28)$$

In the next section we will show:

$$N = 2.6 \times 10^{45}$$

Therefore, inserting the value of r (from equation 28) onto equation 27, and putting $nc_o = N$ enable us to have one unknown so, we can estimate: $n = 5.8 \times 10^{21}$

And then from equation 26 we can get

$$p = 4.4 \times 10^9 \text{ Proton.}$$

And then from the quantity N , we can define:

$$c_o = 4.5 \times 10^{23}$$

$$\mu = 5.8 \times 10^{35}$$

$$v^2 = c^2 \left(1 - \frac{1}{4.5 \times 10^{23}}\right) \approx c^2$$

$$u_g = 1.6 \times 10^{-34} \text{ joule} \quad (29)$$

The above is estimated from equation (28). Inserting in Newton law the value $n = 5.8 \times 10^{21}$

$$\therefore u^2 \approx 2 \times 10^{-7}$$

$$\frac{n}{p} = 1.3 \times 10^{12}$$

It is useful to notice the physical meaning of equation 12 from the relation $\gamma^2 =$

$$\frac{1}{1 - \frac{c^2 - u^2}{c^2}} = \frac{c^2}{u^2}$$

Summary and results of the above sections:

$$\frac{3}{5} (u_e + u_s + u_g) = m_o c^2 \equiv k \frac{e^2}{r_o} \times 1$$

$$\frac{3}{5} (u_c + u_g) = m_o c^2 \equiv k \frac{e^2}{r_o} \times 1$$

$$\frac{3}{5} u_g = \frac{1}{2} m u^2$$

And, its relativistic quantity (only inside the equations of the paired microstates, like equation 18) obeys

$$-\frac{3}{5} \frac{G m_o^2 (n.c_o)}{r_c n^{\frac{1}{3}}} = u_G(v) \approx \frac{1}{2} m_o c^2 \neq u_g(v) \quad \text{which reveals the **alternate** relativistic solution } (n.c_o) = N$$

Or, written (only inside the equation of the imaginary solution) in its positive form

$$-\frac{3}{5} \frac{G m_o^2 (n\gamma^2)}{r_c n^{\frac{1}{3}}} = \frac{3}{5} \frac{G m_o^2 n}{r_c n^{\frac{1}{3}}} = \frac{1}{2} m u^2$$

II- Physics of the giant atom [4]:

$$\because m_p \approx 1840m_e$$

$$\because ke^2 \frac{p}{r_s} = -G(nc_o) \frac{m_o^2}{r_s} = \frac{1}{2} m_o c^2$$

$$\therefore (u_g)_e = \frac{1}{1840} (u_g)_p = m_e c^2$$

$$\frac{N_e}{N_p} = 1840$$

The above means that the giant electron mass = 1840 times the giant proton mass (because the first needs number of neutrons 1840 times that of the second). Hence, the second would rotate around the first. This inverted atom is not a physical step in creation of the giant atom; it is just a mathematical imagination to understand how physics of the giant atom works.

The giant proton to orbit as a whole (one body) its particles have to be tied well with its sphere otherwise, the protons will depart its sphere and orbit as a singled-particles like rosary beads

$$\therefore G \frac{m^2}{r} N \frac{N}{P} \gtrsim \frac{1}{2} m \frac{N}{P} v_o^2 \gtrsim \frac{1}{2} k \frac{e^2}{R} P \quad (30)$$

where v_o is the speed of the first orbit which equals the escape velocity of an orbiting object.

But, there is still a hidden factor, let us search for.

Suppose we have two cases. The first is a giant proton orbits as one body, and the second case is that its orbital is arranged one by one as rosary beads. To prevent 'case one' from breaking up, we need a further factor. The next discussion may reveal this factor. The stored energy E_s in a capacitor (charging one by one)

$$E_s = \int_0^q \frac{q}{c} dq = \frac{1}{2} Vq$$

There is a lost electric energy (in resistance as heat), and we have only half the quantity. Inserting this factor in equation 30 then the condition is

$$G \frac{m}{r} N (m \frac{N}{P}) \gtrsim \frac{1}{4} (m \frac{N}{P}) v_o^2 \gtrsim \frac{1}{4} k \frac{e^2}{R} P \quad (31)$$

We need only the critical value or the least possible energy $G \frac{m^2}{r} N \frac{N}{P}$ therefore we used the symbol

($\approx$) in the above equations. This symbol is physically meaningful. It enables us to estimate the orbital radius of the giant proton (which orbits as one body) from the equation in which the orbital looks as rosary beads like:

$$2\pi R = (\lambda \frac{P}{N})P \quad (32)$$

Where λ is equivalent to the wave length of the hydrogen atom [5], while in the giant atom, the in-between brackets is representing the wave length of one proton weighted by $\frac{P}{N}$ (this means that the giant atom orbital length equals its wave length $\lambda \frac{P}{N}$ times number of protons). Hence, the wave length of the giant atom is very small and narrow, so that the probability of finding the particle looks as

$$\psi_i^2 = \begin{cases} 1 & i = \lambda \frac{P}{N} \\ 0 & i \neq \lambda \frac{P}{N} \end{cases}$$

The above orbital form does not mean that our orbital looks as rosary beads. It only means that the first orbital just needs the critical form of equation 31 to avoid the rosary beads form, but mathematically we can use equation 32 to define the orbital radius. Now to define the orbital ground speed we have to go further in the depth of the physics of the hydrogen atom.

Recalling that the interior of the energies of the giant charge is zero, and considering that we need to understand the mathematic bases of the orbital of the giant atom, we can imagine the inverted hydrogen atom which has no existence absolutely. It only acts inside the giant atom. Suppose we want to play in the physics of the hydrogen atom, and forget for a moment the quantum mechanics. We will do nothing: we will keep the relative motions, electrostatic force, kinetic and potential energies, and all the other Newtonian laws without changes. All what we do is that we imagine the electron got a mass 1840 as massive as the proton mass. Recalling this extreme difference between the mass of this new electron and the mass of the proton, and recalling the two-body problem, and because we did not introduce any new charge therefore, all what occurs is exchange the mass center of the system to be nearer to the massive body which, here, is this new electron. For simplification let us make our origin coincident with the new mass center, and let the total mass

$$M = m_p + m_e \approx m_e$$

$$r_p = m_e \frac{r}{M} \text{ and } r_e = m_p \frac{r}{M}$$

$$k \frac{e^2}{r^2} = \frac{m_p v_p^2}{r} = \frac{m_e v_e^2}{r}$$

From above we can conclude that this new atom has the same old radius but the massive electron and the old proton exchanged their positions relative to the center of mass of this inverted atom. Classically, we can conclude:

$$r_p = r_{Bohr} \text{ and } v_p = 5 \times 10^4 \text{ m/s [5]}$$

And substituting in equation 31

$$\therefore N = 2.6 \times 10^{45} . \quad (33)$$

In equations 31 and 32 you notice new form appears as $\frac{N}{p}$ for each proton. This could be called 'huge proton' which is the unit of the giant orbit. Basically, we have two microstates for each macro state ($\pm \frac{1}{2} \text{ spin}$). In Compton gas (Fermi), the orbit is formed of number of protons (= number of the macro states = twice the number of the microstates p) times' the wavelength of the huge proton.

Equation 31 takes the shape of the least gravitational potential (inside the giant proton) required to prevent the gradual escape of the outer most layer (the work done to move a particle from the outermost layer to a reference outside the sphere is the least, comparative to the deeper layers). From the definition of the giant proton

$$\therefore P = pc_o = 1.9 \times 10^{33}$$

From equation 32, we estimate the orbital radius

$$R = 7 \times 10^{10} \text{ m. And from}$$

$$m \frac{N}{p} v_o^2 = k \frac{e^2}{R} P \text{ we can ensure the same result. And from above:}$$

$$v_o = 5 \times 10^4 \text{ m per second} \quad (34)$$

$$R = 7 \times 10^{10} \text{ m} \quad (35)$$

These match v and R of Mercury planet.

From definition of the giant proton and giant electron:

the sun mass M_s relative to the mass of all the planets combined $\sum M_p$ obeys

$$\frac{M_s}{\sum M_p} = 1840$$

From the present physical values of the solar system; sun mass is about $2 \times 10^{30} kg = 700$ times as massive as the mass of all the planets combined [6].

Jupiter: the massive planet in the solar system was born small, with mass about one over fifteen from its present mass, then it reached gradually to its present mass after millions of years [6].

Taking this old mass of Jupiter in our estimation, we can estimate the present ratio

$$\frac{M_s}{\sum M_p} = 700. \quad (36)$$

This matches the observed mass ratio. We can rewrite equation 31 in the next form

$$G \frac{m}{r} N(m \frac{N}{P}) \gtrsim \frac{1}{4} (m \frac{N}{P}) (v_o^2 + d^2) = \frac{1}{4} k \frac{e^2}{R \cdot d^2} P$$

So, we can define complicated giant proton with higher orbitals to match the physical properties of the higher planets. The above new factor is a positive natural or rational number lies between 1 and 10.

III- The fate of the giant atom

Can we approach two or more of similar giant charges?

No, we cannot. Although the field inside each one alone is zero, yet it is so great between two or more. Displacing two spheres similar in the charge to collect together with the same density needs infinite work.

Go to fire! Actually, this is a bad surprise, but the matter to us here is that; the giant atom drew the physical properties of the orbitals. So in the next two sections we may see a good surprise.

IV- Thermodynamics of the giant atom

From the previous chapters; the net kinetic energy inside the giant proton equals the zero electric plus the zero quantum energy plus the gravitational kinetic energy. Inserting equation 28, and then putting $N \approx 3 \times 10^{45}$ Therefore, the net energy equals

$$u_g(N) = \sum_n^N 0 + G \frac{3}{5} \frac{m \cdot N}{r} m \approx 10^{-5} \text{ MeV} \quad (37)$$

Henceforth, this quantity will prevail and achieve the radical role in understanding the mechanism of creating the giant atom. Therefore, we have to differentiate between the above quantity and the quantity defined by equation (29), where the relation between both is defined by $N = nc_o$, such that, c_o is the replicating factor which arises from the alternative relativistic solution. Solving the problems of the giant atom (how can we explain its density? And from what the quantity $N = nc_o$ was originated?) needs to understand the following: Because all the interior of the giant charge are zeros and it have not any definition except the value which appears in equation (37) so, let us label each particle inside this sphere by this quantity, and let us rewrite the equation in the form

$$u_g(N) = \sum_n^N 0 + G \frac{3}{5} \frac{m \cdot nc_o}{r} m \approx 10^{-5} \text{ MeV}$$

Labeling the particle with this quantity is the macroscopic outcome for the microscopic events which had been mentioned in section one. Now I will use the Boltzmann chemical potential distribution function to define the number density of the labeled neutron compared to that of the free neutrons. Now let us at first, remember the next information's:

At time of freeze out ($\approx 0.7 \text{ MeV}$) in the early universe, as in the Standard model, the ratio $\frac{n}{p} = e^{-\frac{\Delta mc^2}{kT}} \approx \frac{1}{6}$

The binding energy of Deuterium $B_D \approx 2.2 \text{ MeV}$.

$$\eta = \frac{n_b}{n_p} \approx 5 \times 10^{-10} [7]$$

The peak of synthesis of deuterium (at $t \approx 2$ minute of BB)

$$u_D = \frac{B_D}{-\ln \eta} \approx 0.1 \text{ MeV} [8] \quad (38)$$

At that time; there was sudden burst of deuterium synthesis and rapid consumption of the free neutrons. The curve grows rapidly at 2 minute. After 3 minutes the rate became roughly constant [Hou et al 2017].

Now, we will search for the suitable time in the early universe which enables $u_g(N)$ to survive. Because it is small (10 eV) so, the universe should be cold enough to its probable existence otherwise it would be destroyed completely by the energetic photons. But also it should be hot enough to precede the peak rate of deuterium synthesis otherwise the giant charge would not find enough considerable amount of free neutrons. This means that the suitable time to discuss probability of finding the giant protons is roughly at 0.1 MeV

From all above; the number of the particles in a defined phase (giant protons) relative to the number of the particles of the medium (universe) equals the probability to find number of particles with 10^{-5} MeV among $T = 0.1 \text{ MeV}$

Let me use the distribution function using the symbol l as an expression for the mass of the labeled bound particle inside the sphere, and the symbol f for the mass of the free neutron outside it. Since, the bound particle has potential while the free one doesn't have so

$l < f \rightarrow -l > -f$ Therefore, we can write

$$f(l) = \left(\frac{l}{f}\right)^{\frac{3}{2}} e^{\frac{f-l}{T}} \eta \quad (39)$$

Putting $\eta \approx 10^{-9}$

$$\therefore \frac{n_l}{n_f} = 10^{-9} e^{\frac{10^{-5}}{0.1}} \approx 10^{-9} \quad (40)$$

But, we have to search for the mass between the bound particles inside the sphere which is missed here while it appeared in the first section in the form of $m_o c^2$ as in equation (23). I can suggest the next reaction:

One free particle plus another free one produces one bound labeled particle plus potential energy, therefore we can rewrite: By the thermal collision: $(n + n)_f = (n)_l + 10^{-5} MeV$. And from section 1, we can understand that the labeled particle is weighted as; $m_o 2c^2 \equiv 2m_o c^2$. This equation goes strait forwarded with the final result of equation (39) because we still can write the difference of the masses in joule, in the reaction inside equation (40), in the form: $f - l = 10^{-5} MeV$. Moreover, since that the difference in mass between the labeled particle and the particle of deuterium equals $m_l - m_D = l - D = 2.2 MeV$ therefore the number density of the labeled particles to that of Deuterium:

$$f(l) = \frac{n_l}{n_D} \approx e^{\frac{-l+D}{T}} \approx e^{\frac{D-l}{T}} = e^{-22} \approx 10^{-9}$$

It appears now that the microscopic income (the extreme speed) which appeared in the first section isn't more than a macroscopic replication outcome (as in equations 1 and 27). And this replication is actually not more than introducing excess free particles from the surrounding into a new state inside our sphere so that the entire number of the particles of the whole universe is the same without change. Because the net energy of the particle $= u_g \approx 10^{-5} MeV$ is a function in N and r of the sphere so, this density function gives here, description for the sphere-bound particles and a description of the whole sphere. The function defines the probable ratio of the number of all the particles of all the spheres (of the proposed solar -like systems) combined, to all the number of all the particle of the entire observed universe. Also, we notice that this equation (40) cooperates with the alternate relativistic equations (18 and 27) to discover the physical origin of the factor c_o (defined by equation 29) which is incorporated implicitly in equation of the orbital motion (31). I can simplify the concept of our paper as: Since it is impossible to arrive to speed of light then let us ask about the cause. If the cause was that it needs extreme energy then let us ask about energy. If it is equivalent to matter then let us ask about matter. If it is particles then let us use particles to arrive to the extreme speed. If we cannot do but the old universe did then let us read the written by the universe. It looks for me that God had created the macroscopic outcome and left us to read the underline microscopic events.

Nevertheless $KT \gg u_g$, however the 'authority' of the probability function guarantees abundance of good number of the spheres (as we will see). From the definition of the giant proton the number N of the particles inside the giant proton $\approx 3 \times 10^{45}$ and the

number of the particles in the seen universe $\approx 10^{80}$ [9]

From above, and from equation 40, the expected number of the giant protons in the early universe $\approx \frac{10^{80}}{3 \times 10^{45} \times 10^9} \approx 3 \times 10^{25}$ (41)

V- Physics of the primordial solar system

In the first two sections we defined the gravitational binding energy of the giant electron B_e and also we defined the giant atomic orbitals (system) which have orbital binding energy $E_O = E_p - E_k \equiv \frac{1}{2}mv^2$

From equation 31 and 37 we can derive that the gravitational binding energy u_g of the giant proton $u_g = \frac{1}{2} E_O \approx \frac{1}{(1840)^{\frac{2}{3}}} B_e \approx 10^{-5} MeV$

From the first section we can imagine a giant neutron; using the same alternate relativistic solution till we reach to equation 33 and 37, and then we define its distribution function. So, the giant neutron is a giant proton but without charges. Moreover, by the aid of statistics we can define the probability of finding of the orbital of a giant "neutral" atom fixed on the same orbital of the giant atom (like equations 34, 35 and 36). This is the suggested primordial -solar model: it is formed of mini-solar systems. Each system is formed of a giant neutron A , orbiting another one B . The central one is 1840 times as massive as the orbiting one. Then we have different levels (for the different planets) according to the factor d . So, simulating to equation 31, we can write

$$G \frac{m}{r} nm \gtrsim \frac{1}{4} (mn)(v_o^2 + d^2) = \frac{1}{4} G \frac{m.N}{R.d^2} m \quad (42)$$

Here, N is the number of the particles of the central sphere of one unit, while n is the number of the particles of the orbiting one. We suggest also that the summation of A , equals the summation of B . By the gravitational attraction union occurs, and hence forth, Newtonian equations can explain the orbital motion.

But what is the magnitude of the orbital speed here? We can find the answer in equation 31 which summited a principle stating that the kinetic energy of each orbiting particle must be equal or less than the gravitational binding energy. Although equation 31 talks about the giant atom, while here instead, we speak about neutral sphere yet, the above principle prevails also here. Since the gravitational energy per particle inside the orbiting charged or neutral sphere is the same in magnitude (because both have the same density and number of particles) therefore, from equations (30) and (34) and putting the radius of the orbit of the **neutral** giant atom equal R_n while that of the giant atom of equation (30) equal R .

$$G \left(\frac{mN}{r} \right) = \frac{1}{4} v_o^2 = \frac{1}{4} \times (5 \times 10^4)^2 = G \frac{mN}{R_n}$$

$$\therefore R_n \approx 0.5 \text{ m} \ll R$$

This small orbit length was suitable for the old dense small universe. Now, considering the subscripts i for the initial mini system and no subscript for the final form after the collection Σ :

$$v_o^2 = G \Sigma \frac{M_i}{R_i} = G \frac{M}{R} = v^2 \quad (43)$$

This is the simple equation controlling the planet motion (the right equality), but with the hidden hereditary giant atom physics (the left one).

Actually, the big sphere had created thermally, such that it was pregnant and carrying the units of small spheres with homogeneous density. So, we can speak about primordial thermal creation of the big sphere, but we cannot do that for the small one alone. Why? Because first, you notice that we defined -in the first section- the small sphere by using the value of N of the big sphere (as defined in the second section). Second, u_g of the small sphere is hidden inside the zero energy (as equation 22), while in the big sphere we notice that its binding energy appears by adding non-zero term as in the next function

$\Sigma_n^N 0 + f \left(\frac{N}{n} \right)^{\frac{2}{3}} \approx 10^{-5} \text{ MeV}$ (equation 37). By this meaning we have to understand the alternate relativistic solution of equations 25 and 27 on the light of the genius thermodynamic equation 40. Since all the equations (the alternate relativistic and the thermodynamics) speak about the big sphere, then, to complete our success we have to find the physical tools to approach many of

these giant atoms and collect them together. But collecting positive (or negative) spheres needs infinite work have to be done. Hence, the theory collapses. This made us adopt the same theory but with neutral big spheres.

VI- Thermo statistics of the solar systems

Now, the sun has about 10^{57} *particle* and consequently, all the planets (of our solar system) have about 10^{54} *particle*. So that, they had number of giant neutrons (in the early universe) $\approx \frac{10^{54}}{3 \times 10^{45}} \approx 3 \times 10^8$.

Inserting equation 41, we expect

Solar-like system in the universe had been created as in our $\frac{3 \times 10^{25}}{3 \times 10^8} \approx 10^{17}$ model. (44)

VII- Elements abundance in our model:

BBN results in mass abundance about seventy five percent hydrogen and the reminder as helium. At the universe temperature was 0.7 Mev the proton neutron ratio was $6 : 1$ but few minutes later, by decay of neutrons, it became $7 : 1$. Our model agrees with all above. It speaks only about very small zones of the early universe occupied by the giant neutrons. Inside our sphere, the neutron proton ratio inside our sphere was roughly **one to zero**. The neutrons were two minutes old, and have to decay because they have average life time about fifteen minute. $N = N_0 e^{\frac{-t}{\tau}} \approx N_0 e^{\frac{-2}{15}} \approx 0.87$

$$\begin{array}{ccc} n & : & p \\ \downarrow & & \downarrow \\ 87 & : & 13 \\ \downarrow & & \downarrow \end{array}$$

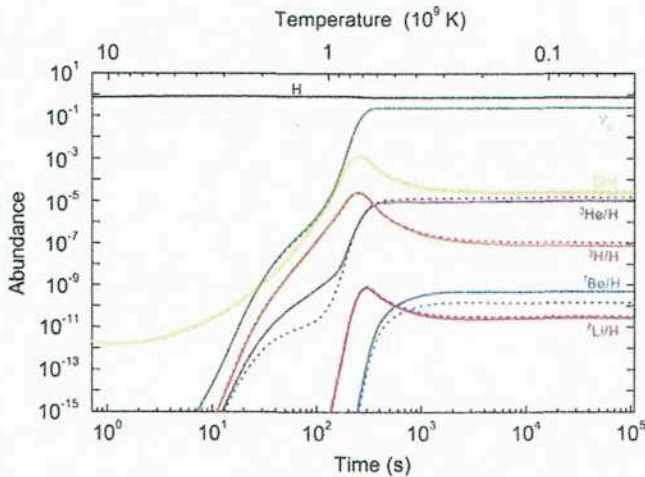
$$75 n + 6 \text{ pairs} : 6 \text{ pairs}$$

These six pairs (percent) fuse to form about twenty-five percent mass abundance of helium. By time pass, the temperature falls enough to prevent further considerable fusion, but of course would not prevent neutron to decay. So, the remainder seventy five, by time and by neutron decay, would construct seventy

five percent mass abundance of hydrogen (you notice my alternative mechanism which gives results matching the observed values. But, what is the age of the newly born neutrons of the big sphere? We showed that the small sphere ($n \approx 10^{21}$) gave by alternate relativistic solution ARS the big sphere ($N \approx 10^{45}$) at time 2 minute after BB. Was its age at this time two or zero minute? The answer is two minutes, because ARS does not add extra particles. It just means cutting up a big zone from the universe to represent the big sphere of the giant charge. The small one has no existence outside the big sphere but its mathematics is acting inside it. The big sphere did not come after the small one, but both came at the same moment. ARS does not mean more than it is the solution which enables us to equate $\sum_n^N \text{zeros} = \frac{N}{n} m_o c^2$

Summary:

We can put the next as tests for success of our theory: equations 34, and 35 to match the planetary orbitals, and equation 36 and 43 to match the mass of the Sun and its planets. The abundance of the light elements in the universe is another matching. I hope this paper to help the scientists -in the future- to succeed in storing extreme energy. It looks that Allah had written the macroscopic outcome and left us to read the microscopic income of the events.



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Conclusion

The famous Einstein's equation ($E_o = m_o c^2$) can describe the rest energy of a particle; similarly, I submitted the same equation to describe a closed sphere, filled with particles. Hence, we put all the energies inside the sphere which contains this bound state of the particles in a rest state. Hence, we can add these rest energies of the particles as summation of zeros. This led me to submit for physics of the relativistic giant atom.

This giant atom was created in the early universe. We defined its time of existence after BB, as well as its life time. After that, the orbitals of these giant atoms were maintained by gravity. The old existence of these giant atoms left its cosmological implications in the orbital radii and velocities of the planets of the solar system. Our model succeeded to put explanation for the light elements abundance matching the standard model.

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